

# STRUCTURE, DISTRIBUTION AND TAXONOMIC IMPORTANCE OF TRICHOMES IN *TEPHROSIA* (FABACEAE)

S. RAJA SHANMUKHA RAO

*Plant Anatomy & Taxonomy Laboratory  
Department of Botany, Sardar Patel College  
Secunderabad – 500 025, INDIA*

J.V. SUBBA RAO

*Department of Botany  
Dharmavant College of Science and Commerce  
Yakutpura, Hyderabad – 500 023, INDIA*

## ABSTRACT

Structure, organographic distribution and taxonomic importance of trichomes in sixteen species of *Tephrosia* Pers. are described for the first time based on LM and SEM studies. Trichomes are either unicellular or multicellular and categorized into unicellular, uniseriate filiform and uniseriate macroform. Taxonomic utility of styler trichiferous condition in *Tephrosia* is emphasized once again in the Indian context. The taxonomic significance and circumscription of *Tephrosia* in relation to other genera within tribe Galegeae are discussed based on the distribution of trichomes. A key is presented to delimit the sixteen species studied utilizing organographic distribution of trichome types.

## INTRODUCTION

Trichomes offer more valuable taxonomic information than all the other epidermal elements because of their diversity in structure as well as distribution (Stace 1989; Shanmukha Rao 1991). In *Tephrosia* Pers., the earlier data has been related primarily to stomata, not to trichomes (Shah & Gopal 1969; Shah et al. 1975; Shah & Kothari 1976; Bhatt & Tuteja 1984). Therefore, the objective is to describe the structure, organographic distribution, and taxonomic importance of trichome types in sixteen species of *Tephrosia* based upon Light Microscopic (LM) and Scanning Electron Microscopic (SEM) studies.

## MATERIALS AND METHODS

The details of the 16 species investigated are presented in Table 1. Of these, *T. barberi*, *T. canarensis*, *T. roxburghiana* and *T. wynaadensis* are rare, endangered and little known endemics of South India (Nair & Henry 1983).

LM study: Trichomes were studied from epidermal peelings obtained by scrapping the young and mature parts. Boiling herbarium specimens in dilute nitric acid was found necessary. Petals and stamens however, were directly



TABLE 1. List of *Tephrosia* species investigated.

| S. No. | Name of the species                           | Locality/Source of material | Nature |
|--------|---|-----------------------------|--------|
| 1.     | <i>T. barberi</i> Drumm.                      | BSI, SC, Coimbatore         | HM     |
| 2.     | <i>T. canarensis</i> Drumm.                   | BSI, SC, Coimbatore         | HM     |
| 3.     | <i>T. candida</i> (Rob.) DC                   | BSI, SC, Coimbatore         | HM     |
| 4.     | <i>T. hamiltonii</i> Drumm.                   | Hyderabad, AP               | FM     |
| 5.     | <i>T. hookeriana</i> Wt. & Arn.               | BSI, SC, Coimbatore         | HM     |
| 6.     | <i>T. maxima</i> (L.) Pers.                   | Hyderabad, AP               | FM     |
| 7.     | <i>T. pulcherrima</i> (Wt. ex Baker) Drumm.   | BSI, SC, Coimbatore         | HM     |
| 8.     | <i>T. pumila</i> (Lam.) Pers.                 | Hyderabad, AP               | FM     |
| 9.     | <i>T. purpurea</i> (L.) Pers.                 | Hyderabad, AP               | FM     |
| 10.    | <i>T. roxburghiana</i> Drumm.                 | BSI, SC, Coimbatore         | HM     |
| 11.    | <i>T. spinosa</i> (L.) Pers.                  | Warangal, AP                | FM     |
| 12.    | <i>T. strigosa</i> (Dalz.) Santapau & Mahesh. | Hyderabad, AP               | FM     |
| 13.    | <i>T. tinctoria</i> Pers.                     | Tirupati, AP                | FM     |
| 14.    | <i>T. villosa</i> (L.) Pers.                  | Hyderabad, AP               | FM     |
| 15.    | <i>T. vogelii</i> Hoof. f.                    | BSI, SC, Coimbatore         | HM     |
| 16.    | <i>T. wynaadensis</i> Drumm.                  | BSI, SC, Coimbatore         | HM     |

AP = Andhra Pradesh, India; BSI = Botanical Survey of India;

FM = Fresh material; HM = Herbarium material; SC = Southern Circle

mounted as such. The micropreparations were then stained with safranin and mounted in 80% glycerin.

**SEM study:** Plant parts were cut into small pieces and mounted on brass stubs. Then they were coated with gold at 1.2 kV under high vacuum and observed under a JEOL JSM -35 Scanning Electron Microscope at a constant power supply of 20 kV.

The data presented were mainly based on LM studies and SEM data supplements the observations made on LM, especially to understand surface ornamentation of trichomes. The sample includes five specimens in each species excepting for two specimens in case of rare material. The voucher specimens were deposited in the Department of Botany, Sardar Patel College, Secunderabad, India.

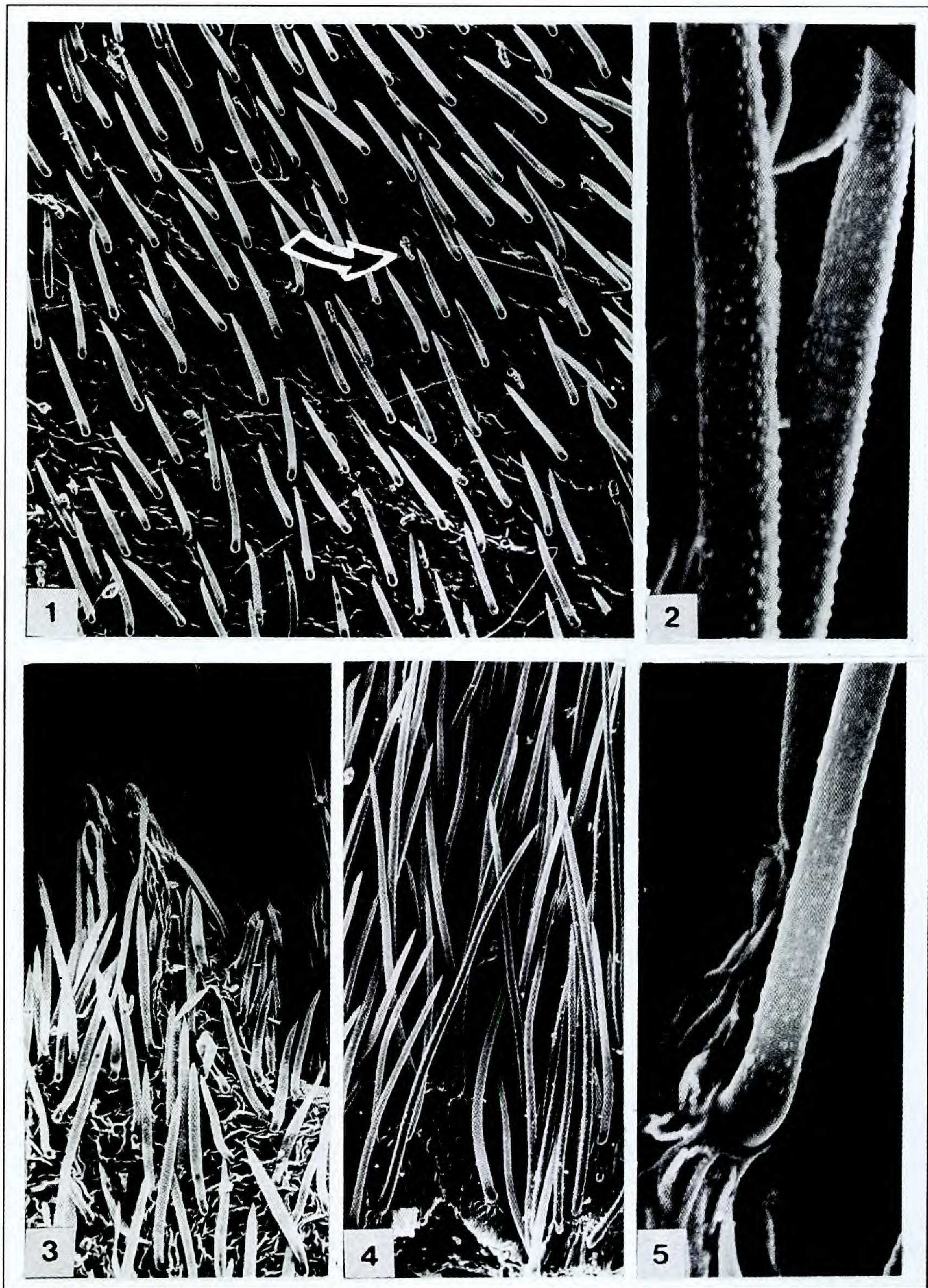
**Terminology:** Each trichome basically consists of two parts, the foot and the body (Ramayya 1981). The former is mostly embedded in the epidermis while the latter constitutes the emergent part. The body may be entire or often in many trichome types shows further differentiation into a stalk and a head.

#### OBSERVATIONS

Three trichome types could be recognized in the species studied. Structural details are presented below.

**1. Unicellular papillate hair:** Foot: Indistinct from the body, embedded in the epidermis; wall thin, contents scanty. Body: Represented by a slight





FIGS. 1 – 5: Scanning electron micrographs of trichomes in *Tephrosia*; 1. *T. strigosa*: Uniseriate macroform conical and occasional uniseriate filiform clavate hairs (arrow) from ovary wall,  $\times 100$ ; 2. *T. strigosa*: Part of uniseriate macroform conical hair from ovary wall showing tuberculate surface,  $\times 1000$ ; 3. *T. strigosa*: Uniseriate macroform conical hairs from sepal abaxial,  $\times 100$ ; 4. *T. vogelii*: Uniseriate macroform conical hairs from leaf abaxial,  $\times 100$ ; 5. *T. vogelii*: Base of the uniseriate macroform conical hair from leaf abaxial,  $\times 600$ .





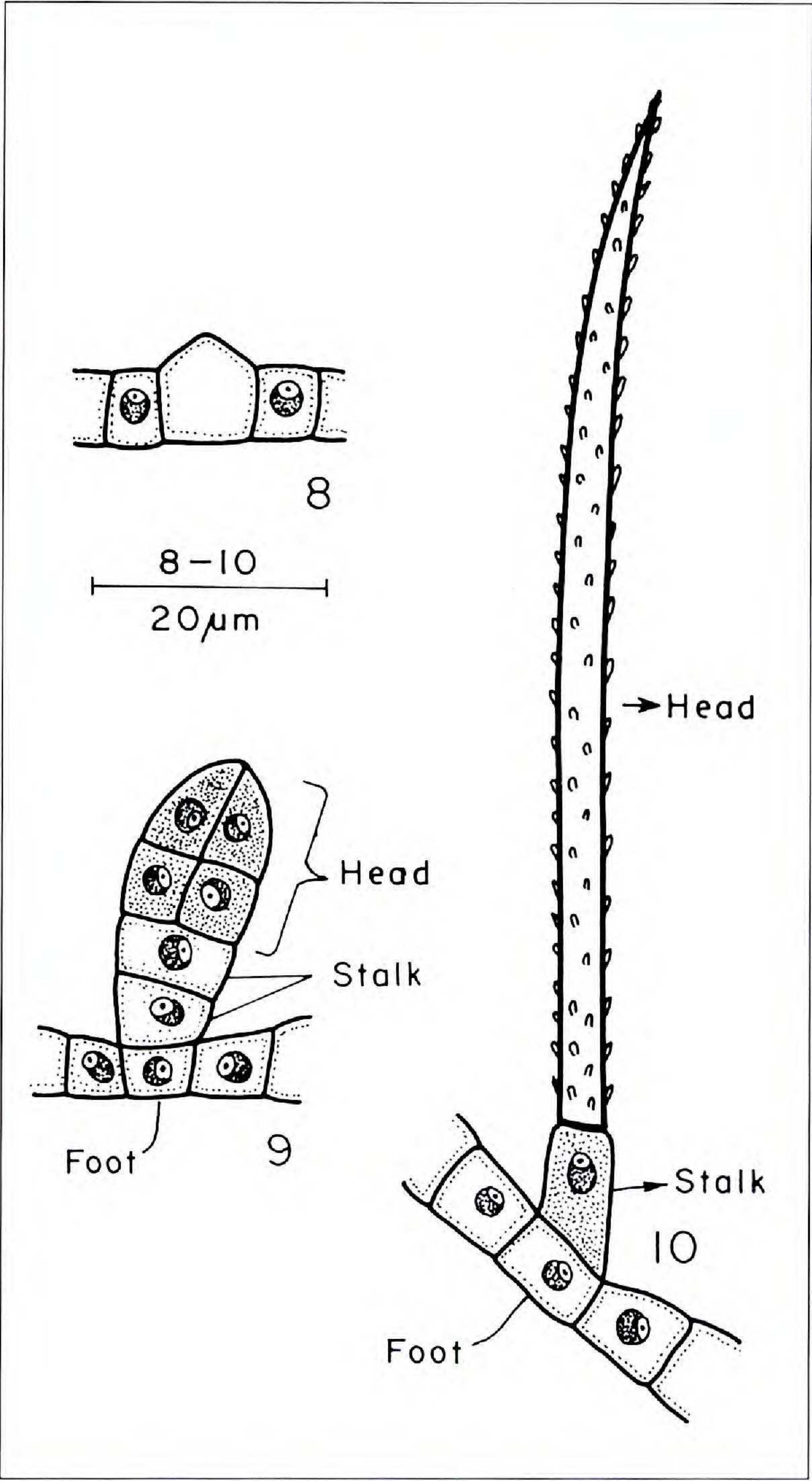
FIGS. 6–7: 6. *T. hamiltonii*: Uniseriate macroform conical hairs and uniseriate filiform clavate hairs (arrow) from the stem,  $\times 360$ ; 7. *T. barberi*: Uniseriate macroform conical hairs from rachis,  $\times 80$ .

projection above epidermis, inconspicuous in surface view; papillate, apically acute or slightly obtuse; wall thin, surface smooth, contents scanty (Fig. 8).

**2. Uniseriate filiform clavate hair:** Foot: One celled, projected slightly above the epidermis; wall thin, contents scanty. Stalk: Uniseriate, cylindrical, 1 – 3 celled, cells usually broader than long; cross walls straight and thin, lateral walls thin, surface smooth, contents dense. Head: Clavate, uni-, bi-, or multiseriate, 1 – 3 tiered with 2 – 4 cells per tier, cells usually broader than long; walls thin, surface smooth, contents dense (Figs. 1, 6, 9).

**3. Uniseriate macroform conical hair:** Foot: One celled, bulbous, projected slightly above the epidermis, base rounded; wall thick, contents scanty. Stalk: One celled; wall thin, contents scanty. Head: One celled, elongate, length variable, apex acute; walls thick, surface tuberculate, granulate or smooth, contents absent (Figs. 1 – 7, 10).





FIGS. 8–10: 8. *T. strigosa*: Unicellular papillate hair from standard petal adaxial; 9. *T. maxima*: Uniseriate filiform clavate hair from sepal abaxial; 10. *T. maxima*: Uniseriate macroform conical hair from sepal abaxial.



KEY FOR THE IDENTIFICATION OF HAIR TYPES IN *TEPHROSIA*

1. Hair unicellular ..... *Unicellular papillate hair*
1. Hair multicellular and uniseriate.
  2. Hair macroform and conical; consists of foot and body; body differentiated into one celled proximal stalk and one celled conical head which is dead at maturity ..... *Uniseriate macroform conical hair*
  2. Hair filiform and clavate; consists of foot and body; body further differentiated into a proximal stalk and a distal clavate head ..... *Uniseriate filiform clavate hair*

The data for organographic distribution of trichomes encountered on the vegetative parts are presented in Table 2 and on the floral parts in Table 3.

## DISCUSSION

a) **Structure**

The trichome types reported earlier in the Papilionoideae are either unicellular (Leelavathi & Ramayya 1983; Vijay Kumar 1988) or multicellular (Solereeder 1908; Sabnis 1920; Metcalfe & Chalk 1950; Shah & Kothari 1973, 1975; Kothari & Shah 1974, 1975; Lackey 1981; Leelavathi & Ramayya 1983; Vijay Kumar 1988). The multicellular trichomes in *Tephrosia* are uniseriate exclusively whereas biseriate and multiseriate trichome categories, though reported earlier in the Papilionoideae (Leelavathi & Ramayya 1983; Vijay Kumar 1988) are totally absent in *Tephrosia*. Further, it appears that the ubiquitous presence of unicellular and uniseriate trichome categories and absence of biseriate and multiseriate ones in *Tephrosia* is interesting and taxonomically significant. This taxon stands apart from other genera of tribe Galegeae as the latter possess biseriate and multiseriate trichome categories in addition to unicellular and uniseriate ones (Prabhakar et al. 1985; Vijay Kumar 1988). This stresses the need to probe further into distributional aspects of trichomes at intergeneric level in the tribe Galegeae vis-a-vis their taxonomic circumscription.

Trichomes in *Tephrosia* possess a simple foot that is projected slightly above the epidermis. The body of the trichome is entire in unicellular papillate hairs whereas in uniseriate ones, it exhibits a stalk and a head. The uniseriate macroform conical hair, also referred to as the 'ordinary simple papilionaceous hair' or '3-celled hair' by Solereeder (1908) and Metcalfe & Chalk (1950) respectively, invariably consists of only 3 cells including the foot cell (except in *T. strigosa*, where the hair is mostly 2-celled) with two shorter proximal cells and a very long distal cell (Fig. 10).

The wall of uniseriate macroform conical hair is thick whereas it is thin in unicellular papillate and uniseriate filiform clavate hairs. The surface is smooth in unicellular papillate and uniseriate filiform clavate hair types whereas in uniseriate macroform conical hair, the head is tuberculate (Figs. 2, 5) in all the plant parts except on the petal where it is smooth under LM but granulate under SEM.



TABLE 2. Organographic distribution of trichome types in the vegetative parts in *Tephrosia* Pers.

| S. No. Name of the species | Leaf  |     |     | Rachis/Petiolule<br>Petiole |     | Stipule |     |     | Stem  |
|----------------------------|-------|-----|-----|-----------------------------|-----|---------|-----|-----|-------|
|                            | Ab    | Ad  | M   |                             |     | Ab      | Ad  | M   |       |
| 1. <i>T. barberi</i>       | B,C   | B,C | B,C | B,C                         | B,C | B,C     | B,C | B,C | B,C   |
| 2. <i>T. canarensis</i>    | B,C   | C   | B,C | B,C                         | B,C | C       | —   | B,C | B,C   |
| 3. <i>T. candida</i>       | B,C   | B,C | B,C | B,C                         | B,C | B,C     | —   | B,C | B,C   |
| 4. <i>T. hamiltonii</i>    | B,C   | B,C | B,C | B,C                         | B,C | B,C     | B,C | B,C | B,C   |
| 5. <i>T. hookeriana</i>    | B,C   | B,C | B,C | B,C                         | B,C | B,C     | B,C | B,C | B,C   |
| 6. <i>T. maxima</i>        | B,C   | B,C | B,C | B,C                         | B,C | B,C     | B,C | B,C | B,C   |
| 7. <i>T. pulcherrima</i>   | A,B,C | C   | B,C | B,C                         | B,C | B,C     | —   | B,C | A,B,C |
| 8. <i>T. pumila</i>        | B,C   | B,C | B,C | B,C                         | B,C | B,C     | —   | B,C | B,C   |
| 9. <i>T. purpurea</i>      | B,C   | B,C | B,C | B,C                         | B,C | B,C     | B,C | B,C | B,C   |
| 10. <i>T. roxburghiana</i> | C     | C   | B,C | B,C                         | B,C | B,C     | B,C | B,C | B,C   |
| 11. <i>T. spinosa</i>      | B,C   | B,C | B,C | B,C                         | B,C | C*      | C*  | C*  | B,C   |
| 12. <i>T. strigosa</i>     | B,C   | B,C | B,C | B,C                         | **  | B,C     | —   | B,C | B,C   |
| 13. <i>T. tinctoria</i>    | B,C   | —   | B,C | B,C                         | B,C | B,C     | —   | B,C | B,C   |
| 14. <i>T. villosa</i>      | B,C   | B,C | B,C | B,C                         | B,C | B,C     | —   | B,C | B,C   |
| 15. <i>T. vogelii</i>      | B,C   | B,C | B,C | B,C                         | B,C | B,C     | —   | B,C | B,C   |
| 16. <i>T. wynaadensis</i>  | B,C   | B,C | B,C | B,C                         | B,C | B,C     | —   | B,C | B,C   |

A = Unicellular papillate hair; B = Uniseriate filiform clavate hair; C = Uniseriate macroform conical hair; — = Trichomes absent; \*\* = Part absent; \* = Modified into a spine; Ab = Abaxial; Ad = Adaxial; M = Margin.



TABLE 3. Organographic distribution of trichome types in the floral parts in *Tephrosia* Pers.

| S. No. | Name of the species    | Peduncle/<br>Pedicel | Bract |     |     | Sepal |     |     | Standard petal |     |     | Wing petal |    |   | Keel petal |    |     | Stamen | Ovary | Style |
|--------|------------------------|----------------------|-------|-----|-----|-------|-----|-----|----------------|-----|-----|------------|----|---|------------|----|-----|--------|-------|-------|
|        |                        |                      | Ab    | Ad  | M   | Ab    | Ad  | M   | Ab             | Ad  | M   | Ab         | Ad | M | Ab         | Ad | M   |        |       |       |
| 1.     | <i>T. barberi</i>      | B,C                  | B,C   | B,C | B,C | B,C   | B,C | B,C | C              | A   | C   | C          | A  | – | –          | –  | A   | –      | B,C   | –     |
| 2.     | <i>T. canarensis</i>   | B,C                  | B,C   | –   | B,C | B,C   | –   | B,C | C              | A   | B,C | –          | A  | – | –          | –  | A   | –      | B,C   | C     |
| 3.     | <i>T. candida</i>      | B,C                  | B,C   | –   | B,C | B,C   | –   | B,C | C              | A   | C   | –          | A  | – | –          | –  | A   | –      | C     | C     |
| 4.     | <i>T. hamiltonii</i>   | B,C                  | B,C   | B,C | B,C | B,C   | B,C | B,C | C              | A   | C   | C          | A  | – | –          | –  | A   | –      | C     | –     |
| 5.     | <i>T. bookeriana</i>   | B,C                  | B,C   | B,C | B,C | B,C   | B,C | B,C | C              | A   | C   | –          | A  | – | C          | –  | A   | –      | C     | –     |
| 6.     | <i>T. maxima</i>       | B,C                  | B,C   | –   | B,C | B,C   | B,C | B,C | B,C            | A   | B,C | –          | A  | – | C          | –  | A   | –      | B,C   | B,C   |
| 7.     | <i>T. pulcherrima</i>  | B,C                  | B,C   | –   | B,C | B,C   | –   | B,C | C              | A   | C   | C          | A  | – | C          | –  | A   | –      | C     | C     |
| 8.     | <i>T. pumila</i>       | B,C                  | B,C   | –   | B,C | B,C   | –   | B,C | C              | A   | C   | –          | A  | – | –          | A  | A   | –      | B,C   | –     |
| 9.     | <i>T. purpurea</i>     | B,C                  | B,C   | B,C | B,C | B,C   | B,C | B,C | C              | A   | C   | –          | A  | – | C          | –  | A,C | –      | C     | –     |
| 10.    | <i>T. roxburghiana</i> | B,C                  | B,C   | –   | B,C | B,C   | –   | B,C | C              | A   | C   | –          | A  | – | –          | –  | A   | –      | C     | C     |
| 11.    | <i>T. spinosa</i>      | B,C                  | B,C   | –   | B,C | B,C   | –   | B,C | C              | A   | A,C | –          | A  | – | –          | A  | A   | –      | C     | –     |
| 12.    | <i>T. strigosa</i>     | B,C                  | B,C   | –   | B,C | B,C   | –   | B,C | C              | A   | C   | –          | A  | – | –          | A  | A   | –      | B,C   | –     |
| 13.    | <i>T. tinctoria</i>    | B,C                  | B,C   | –   | B,C | B,C   | –   | B,C | C              | A   | C   | –          | A  | – | –          | –  | A   | –      | C     | C     |
| 14.    | <i>T. villosa</i>      | B,C                  | B,C   | –   | B,C | B,C   | C   | B,C | C              | A   | C   | –          | A  | – | C          | –  | A   | –      | C     | –     |
| 15.    | <i>T. vogelii</i>      | B,C                  | B,C   | –   | B,C | B,C   | B,C | B,C | B,C            | A,C | B,C | –          | A  | C | C          | –  | A   | –      | B,C   | C     |
| 16.    | <i>T. wynaadensis</i>  | B,C                  | B,C   | C   | B,C | B,C   | –   | B,C | B,C            | A   | B,C | –          | A  | – | –          | A  | A   | –      | C     | C     |

A = Unicellular papillate hair; B = Uniseriate filiform clavate hair; C = Uniseriate macroform conical hair; – = Trichomes absent; Ab = Abaxial; Ad = Adaxial; M = Margin.



## b) Distribution

All the vegetative as well as floral parts excluding the stamens are frequently trichiferous in *Tephrosia* presently studied. However, stamens are trichiferous towards their proximal ends in some *Tephrosia* occurring in Malesia (Bosman & de Haas 1983). In comparison, none of the Indian taxa studied exhibited hairy stamens.

The presence of papillate condition in the floral parts of many angiosperms is a common feature, being an adaptation for insects to land during pollination. This condition is confirmed on the adaxial surfaces of standard and wing petals as they possess unicellular papillate hairs uniformly in all taxa studied. However, keel petals possess these hairs on their adaxial surface in only four taxa, viz. *T. pumila*, *T. spinosa*, *T. strigosa* and *T. wynaadensis* (Table 3). This rare occurrence is probably because keel petals are folded and their adaxial surfaces are not completely exposed. However, the outer margins of keel petals in all the taxa studied possess these hairs.

The presence of papillose lower epidermis of the leaf has been reported in many taxa of Leguminosae, but not in *Tephrosia* (Solereder 1908; Metcalfe & Chalk 1950). Presently, this condition with occasional unicellular papillate hairs is observed on the leaf's abaxial surface only in *T. pulcherrima* and hence this taxon stands apart from the rest. The abaxial surface in the leaf, stipule, bract and sepal, including the margins, is trichiferous in the taxa studied (Fig. 3). The trichomes form a dense covering on the leaf's abaxial surface, sometimes making it even difficult to observe epidermal cells and stomata in *T. barberi*, *T. canarensis*, *T. candida*, *T. hookeriana*, *T. pulcherrima*, *T. roxburghiana*, *T. tinctoria*, *T. vogelii* (Fig. 4) and *T. wynaadensis*.

The adaxial surface presents a slightly different picture in comparison with the abaxial surface of the laminar parts. The leaf's adaxial surface is trichiferous in all taxa studied excepting *Tephrosia tinctoria*, whereas the stipule's adaxial surface is trichiferous in *T. barberi*, *T. hamiltonii*, *T. hookeriana*, *T. maxima*, *T. purpurea* and *T. roxburghiana* (Table 2). However, the bract's adaxial surface is trichiferous only in *T. barberi*, *T. hamiltonii*, *T. hookeriana*, *T. purpurea* and *T. wynaadensis* and the sepal's adaxial surface in *T. barberi*, *T. hamiltonii*, *T. hookeriana*, *T. maxima*, *T. purpurea*, *T. villosa* and *T. vogelii* (Table 3).

Distribution of trichomes among different petals in *Tephrosia* is interesting. The standard petal alone exhibits a conspicuous presence of multicellular trichomes compared to the wing and keel petals. The abaxial surface of the standard petal is characterized by uniseriate macroform conical hairs in all taxa. However, their distribution pattern is unique. The standard petal is orbicular with an obtuse to emarginate apex. It consists of a claw and a limb. The trichomes are absent on the claw, the lower middle part of the limb and proximal margins. Interspersed with uniseriate macroform conical hairs are uniseriate filiform



clavate hairs borne occasionally on the abaxial surface in *T. maxima*, *T. vogelii* and *T. wynaadensis*.

Uniseriate macroform conical hairs are absent on the adaxial surface of standard petals except in *Tephrosia vogelii* where these hairs are present in the distal half, thereby making it a distinct taxon. In addition, the margin of the standard petal possesses unicellular papillate hairs in *T. spinosa* and uniseriate filiform clavate hairs in *T. canarensis*, *T. maxima*, *T. vogelii* and *T. wynaadensis*.

The wing and keel petals in *Tephrosia* generally are devoid of multicellular hairs, but rarely uniseriate macroform conical hairs are seen on the wing petal's abaxial surface in *T. barberi*, *T. hamiltonii* and *T. pulcherrima*, on the wing petal's margin in *T. vogelii*, on the keel petal's abaxial surface in *T. hookeriana*, *T. maxima*, *T. pulcherrima*, *T. purpurea* and *T. villosa* and on the keel petal's margin in *T. purpurea*. However, these conical hairs are common in *T. vogelii* and dense along the joint of the keel petals on their abaxial surface.

The axiate vegetative parts (rachis/petiole, petiolule and stem) in *Tephrosia* are trichiferous, possessing both uniseriate filiform clavate and uniseriate macroform conical hairs. The peduncle and pedicel exhibit a similar trichome distribution in the respective species.

The ovary is covered by a dense clothing of the uniseriate macroform conical hairs. However, it also possesses the uniseriate filiform clavate hairs in *T. barberi*, *T. canarensis*, *T. maxima*, *T. pumila*, *T. strigosa* (Fig. 1) and *T. vogelii*.

### c) Taxonomic Importance

Wood (1949) divided the New World species of *Tephrosia* into two groups, one with a glabrous style and the other with a pubescent style. Gillett (1959) adopted this classification in African species of *Tephrosia*. Subsequently, Brummitt (1981) divided the genus into two subgenera, subg. *Tephrosia* characterized by a glabrous style and subg. *Barbistyla* by a pubescent style. However, Bosman & de Haas (1983) in their revision of Malesian *Tephrosia* did not give importance to this distinction as the number of species in Malesia with pubescent style is limited. However, the style's pubescence is considered as an important character in delimiting Indian *Tephrosia*, as the pubescent style occurs in eight species viz. *T. canarensis*, *T. candida*, *T. maxima*, *T. pulcherrima*, *T. roxburghiana*, *T. tinctoria*, *T. vogelii* (an African sp. cultivated in India) and *T. wynaadensis*. Trichomes are present either throughout the distal half of the style or on only one side of that half. The trichome type involved is the uniseriate macroform conical hair except in *T. maxima* where uniseriate filiform clavate hairs also intermingle.

Bentham (1865) assigned *Tephrosia* to the tribe Galegeae along with 53 other genera that included *Astragalus*, *Cyamopsis*, *Glycyrrhiza*, *Gueldenstaedtia*, *Indigofera* and *Psoralea*. Polhill & Raven (1981) segregated the genera of Galegeae (sensu lato) and assigned these genera noted above into different tribes e.g. *Tephrosia* in tribe *Tephrosieae*, *Astragalus*, *Glycyrrhiza* and *Gueldenstaedtia* in Galegeae (sensu



stricto), *Cyamopsis* and *Indigofera* in Indigofereae and *Psoralea* in Psoraleae. Solereder (1908) and Metcalfe & Chalk (1950) recorded in the tribe Galegeae (sensu lato), 2-armed hairs in *Astragalus*, *Cyamopsis*, *Indigofera* and *Gueldenstaedtia*, hooked hairs in *Psoralea* and peltate hairs in *Glycyrrhiza*. These three types of hairs are conspicuously absent in *Tephrosia*. Hence, the placement of these genera mentioned above into different tribes by Polhill & Raven (1981) appears justified based upon the distribution of different trichome types.

This clearly demonstrates that trichome distribution in different genera of Galegeae (sensu lato) has taxonomic importance. Further studies in this area could certainly throw more light on the realignment and circumscription of the tribes of the Papilionoideae.

KEY TO TAXA STUDIED BASED MAINLY  
ON ORGANOGRAPHIC DISTRIBUTION OF TRICHOMES

1. Style trichiferous
  2. Trichomes absent on leaf's adaxial surface ..... *T. tinctoria*
  2. Trichomes present on leaf's adaxial surface
    3. Trichomes present on stipule's adaxial surface
      4. Uniseriate macroform conical hairs present on keel petal ..... *T. maxima*
      4. Uniseriate macroform conical hairs absent on keel petal ..... *T. roxburghiana*
    3. Trichomes absent on stipule's adaxial surface
      5. Uniseriate macroform conical hairs present on standard petal's adaxial surface ..... *T. vogelii*
      5. Uniseriate macroform conical hairs absent on standard petal's adaxial surface
        6. Unicellular papillate hairs present on vegetative parts (leaf abaxial and stem) ..... *T. pulcherrima*
        6. Unicellular papillate hairs absent on vegetative parts
          7. Uniseriate macroform conical hairs present on bract's adaxial surface ..... *T. wynaadensis*
          7. Uniseriate macroform conical hairs absent on bract's adaxial surface
            8. Uniseriate filiform clavate hairs present on standard petal's margin and ovary ..... *T. canarensis*
            8. Uniseriate filiform clavate hairs absent on standard petal's margin and ovary ..... *T. candida*
  1. Style glabrous
    9. Trichomes present on sepal's adaxial surface
      10. Trichomes absent on bract's adaxial surface ..... *T. villosa*
      10. Trichomes present on bract's adaxial surface
        11. Uniseriate macroform conical hairs present on wing petal
          12. Uniseriate filiform clavate hairs present on ovary ..... *T. barberi*
          12. Uniseriate filiform clavate hairs absent on ovary ..... *T. hamiltonii*
        11. Uniseriate macroform conical hairs absent on wing petal
          13. Uniseriate macroform conical hairs present on keel petal's adaxial surface and margins ..... *T. purpurea*
          13. Uniseriate macroform conical hairs present on keel petal's adaxial surface only ..... *T. hookeriana*



- 9. Trichomes absent on sepal's adaxial surface
  - 14. Uniseriate filiform clavate hairs present on ovary
    - 15. Uniseriate macroform conical hairs 3-celled ..... *T. pumila*
    - 15. Uniseriate macroform conical hairs mostly 2-celled ..... *T. strigosa*
  - 14. Uniseriate filiform clavate hairs absent on ovary ..... *T. spinosa*

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